complete copy of reference from IDS of 9/8/04

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 371 439 A1

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
17.12.2003 Bulletin 2003/51

(21) Application number: **03253664.1**

(22) Date of filing: **10.06.2003**

(51) Int Cl.[7]: **B23K 9/04**, B23K 10/02, B23K 26/34, B23K 37/06, B23P 6/04, F01D 5/00, F01D 5/18

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PT RO SE SI SK TR
Designated Extension States:
AL LT LV MK

(30) Priority: **10.06.2002 US 167679**

(71) Applicant: **UNITED TECHNOLOGIES CORPORATION**
Hartford, CT 06101 (US)

(72) Inventors:
- **Shah, Dilip M.**
  Glastonbury, CT 06033 (US)
- **Beals, James T.**
  West Hartford, CT 06107 (US)
- **Pietruska, Norman**
  Durham, CT 064222 (US)
- **Szela, Edward R.**
  West Springfield, MA 01089 (US)

(74) Representative: **Leckey, David H.**
Frank B. Dehn & Co.,
179 Queen Victoria Street
London EC4V 4EL (GB)

(54) **Method of weld repairing a component with a refractory metal backing material**

(57) The present invention relates to a method for repairing components such as blades used in turbine engines. The method comprises the steps of placing a piece of refractory metal material (16) over an area of the component to be repaired (12) and depositing a repair filler metal material (20) over the piece of refractory material (16) in an amount sufficient to repair the component and welding the repair filler metal material (20) in place. The refractory metal material (16) may be selected from the group consisting of niobium, tantalum, molybdenum, tungsten, a metal having a melting point higher than the melting point of nickel, and alloys thereof and may be uncoated or coated.

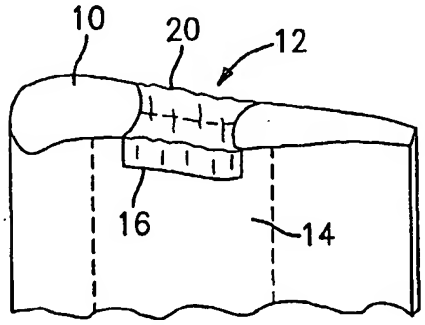

FIG. 1

EP 1 371 439 A1

Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a method for repairing a component, such as a turbine blade or a vane, used in a gas turbine engine.

[0002] Currently, gas turbine blade tips and trailing edge regions are repaired using a welding process such as gas tungsten arc welding without a backing material. The weld bead is used to build up cracked and worn surfaces. Problems occur when blade tip cracks expose blade internal cavities. In this case, the weld will flow into the cavity and result in a rejectable condition. In other areas, such as a blade trailing edge, weld repair will result in closure of the internal cooling features that will then need to be re-established by labor intensive blending or electrodischarge machining.

SUMMARY OF THE INVENTION

[0003] Accordingly, it is an object of the present invention in a preferred embodiment at least to provide an improved method for repairing turbine engine components.

[0004] It is a further object of the present invention in a preferred embodiment at least to provide a method as above which allows welding over open cavities and which does not require extensive post welding blend processing or machining.

[0005] It is yet another object of the present invention in a preferred embodiment at least to provide a method as above which allows re-establishment of internal cooling geometry.

[0006] In accordance with the present invention, a method for repairing a component used in a turbine engine broadly comprises the steps of placing a piece of refractory metal material over an area of the component to be repaired and depositing a repair filler metal material over the piece of refractory metal material in an amount sufficient to repair the component and welding same. The refractory metal material may be any refractory material having a melting point in excess of 1455°C (2651°F) and may be coated or uncoated.

[0007] Other details of the repair method of the present invention, as well as other advantages attendant thereto, are set forth in the following detailed description and the accompanying drawings wherein like reference numerals depict like elements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

FIG. 1 illustrates a tip of a turbine engine blade repaired in accordance with the present invention; and

FIG. 2 illustrates a technique for repairing a trailing edge portion of a turbine engine blade.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0009] In accordance with the present invention, a method is provided for repairing a turbine engine component, such as a turbine blade or vane, formed from a superalloy material, such as a nickel-based or cobalt-based alloy, and used in a gas turbine engine. The method broadly comprises placing a piece of refractory metal material over the area of the component to be repaired and depositing a repair filler metal material over the refractory metal material in an amount sufficient to fill in the space being repaired and welding same. The refractory metal material acts as a backing material for preventing the repair filler metal material from entering internal cavities such as internal cooling cavities.

[0010] Referring now to FIG. 1, a tip 10 of a turbine blade to be repaired is illustrated. The blade tip 10 has an area 12 to be repaired. The blade tip 10 has an open internal cooling cavity 14 in the area to be repaired. In such a circumstance, it is necessary that the internal cooling cavity 14 be protected from the introduction of the repair material. To this end, a piece 16 of backing material formed from a refractory metal material is positioned over the area to be repaired to prevent the entry of the repair material into the cavity 14. The refractory metal material preferably has a melting point in excess of 1455°C (2651°F) and most preferably a melting point in excess of 1650°C (3000°F). Suitable refractory metals for the backing material 16 include, niobium, tantalum, molybdenum, tungsten, metals having a melting point higher than the melting point of nickel, such as platinum, iridium, and the like, and their alloys.

[0011] The refractory metal backing material 16 may be uncoated or coated. If heat input of the repair is high, a diffusion barrier coating can be applied to the refractory material. Candidates include, but are not limited to, oxide ceramics such as alumina or mullite. If an oxide ceramic coating is used, an intermediate coating layer such as a silicide may be used to help coating adherence. When coated with ceramic, it is preferred to nickel plate over the alumina or mullite to aid in wetting the repair filler metal. The coating system may also include a nickel aluminide layer left behind after repair to improve the oxidation resistance of the coating. Alternatively, the refractory metal backing material may just be nickel plated using electrolytic nickel on at least one side if heat input is low. As previously mentioned, the presence of the coating enhances the wettability of the backing material during the subsequent welding process.

[0012] After the refractory metal backing material 16 has been positioned in the area 12, a repair filler metal material 20 is deposited over the backing material 16 and subjected to a welding operation. The repair filler metal material is preferably deposited in an amount sufficient to fill the area 12 to be repaired. The repair filler

metal material may comprise a cobalt based material, such as MERL 72, or a nickel based material, such as INCO 625. Alternatively, the repair filler metal may be a filler metal of the base alloy composition. The repair filler metal material may be applied using any suitable welding technique known in the art such as a TIG repair welding technique. During the welding step, the heat input may be kept low to prevent alloying.

[0013] Once the repair filler metal material 20 has solidified, the refractory metal backing material 16 may be removed by an acid chemical treatment using a nitric acid-sulfuric acid solution. The solution may have 2 parts nitric acid and 1 part sulfuric acid added to 2 parts water. The mixture is preferably heated to a temperature up to 65°C (150°F) to increase the dissolution rate.

[0014] Alternatively, the refractory metal backing material 16 may be removed using an oxidizing heat treatment in which air is flowed through the interior of the blade. The flowing air may be at a temperature in the range of 760°C (1400°F) to 900°C (1650°F) and may be flowed through the blade interior for a time in the range of from 1 to 4 hours. The oxidizing heat treatment may be performed either in a furnace or by direct resistant heating.

[0015] The removal of the refractory metal backing material may be omitted if the alloying of the refractory metal with filler material is controlled.

[0016] Referring now to FIG. 2, a method for repairing a trailing edge 30 of a turbine blade is illustrated. In this method, a piece 32 of refractory metal backing material is first cut to conform to the shape of the blade trailing edge and any internal cooling cavity therein. Any suitable cutting technique known in the art such as laser cutting, photo etching, stamping, or water jet cutting may be used to cut the refractory metal backing material. The refractory metal material may be one of the materials mentioned hereinabove and may be coated or uncoated as discussed above. The piece 32 of refractory metal backing material, preferably in foil form, is placed over the area 34 to be repaired. A repair filler metal material is then deposited over the piece of refractory material 32 and subjected to a welding treatment to re-establish the blade trailing edge including its cooling features 36.

[0017] After the repair filler metal material has solidified, the refractory metal backing material may be removed using either an acid chemical treatment, such as that described above, or an oxidizing heat treatment, such as that described above.

[0018] The present invention is advantageous in that it allows a refractory metal material to act as a weld backing material to allow welding over open cavities or to re-establish internal cooling geometry. The refractory metal material can later be removed if desired without the need for extensive post welding blend processing or machining such as EDM machining. This method has particular utility in the repair of investment castings.

[0019] It is apparent that there has been provided a method for repairing turbine blades which fully satisfies the objects, means and advantages set forth hereinbefore. While the present invention has been described in the context of specific embodiments thereof, other alternatives, modifications, and variations will become apparent to those skilled in the art having read the foregoing description. Accordingly, it is intended to embrace those alternatives, modifications, and variations as fall within the broad scope of the appended claims.

Claims

1. A method for repairing a component comprising the steps of:

   placing a piece of refractory metal material (16; 32) over an area (12;34) of said component to be repaired; and

   depositing a repair filler metal material (20) over said piece of refractory metal material (12; 34) in an amount sufficient to repair said component and subjecting said repair filler metal material to a welding treatment.

2. A method according to claim 1, wherein said placing step comprises placing a piece of material (16;32) formed from a material selected from the group consisting of niobium, tantalum, molybdenum, tungsten, a metal having a melting point higher than the melting point of nickel, and alloys thereof over said area.

3. A method according to claim 1 or 2, wherein said placing step comprises placing a piece of refractory metal material (16;32) having a nickel plating on at least one surface over said area.

4. A method according to claim 1 or 2, wherein said placing step comprises placing a piece of refractory metal material (16;32) having a chromium coating on at least one surface over said area.

5. A method according to claim 1 or 2, wherein said placing step comprises placing a piece of refractory metal material (16;32), having a diffusion barrier coating.

6. A method according to claim 5, wherein said placing step comprises placing a piece of refractory metal material (16;32) having a coating comprising an alumina or mullite coating.

7. A method according to claim 5, wherein said placing step comprises placing a piece of refractory metal material (16;32) having an alumina or mullite coating layer and an intermediate silicide layer.

8. A method according to claim 7, wherein said refractory metal material (16;32) further has a nickel plating over said outer layer.

9. A method according to any preceding claim, wherein said placing step comprises placing a piece of refractory metal material (16;32) having a melting point in excess of 1455°C over said area.

10. A method according to claim 9, wherein said refractory metal material (16;32) has a melting point in excess of 1650°C.

11. A method according to any preceding claim, wherein said component comprises a component for a turbine engine having an internal cooling cavity (14) and said placing step comprises positioning said refractory metal material (16) so as to prevent said repair filler metal material (12) from entering said internal cooling cavity (14).

12. A method according to any preceding claim, wherein said refractory metal material (16) is a cut foil which conforms to a shape of an internal cooling cavity (14) in said component.

13. A method according to any preceding claim, further comprising removing said refractory metal material (16;32) after said welding step has been completed using an acid chemical treatment.

14. A method according to any of claims 1-12, further comprising removing said refractory metal material (16;32) after said welding step has been completed using an oxidizing heat treatment.

15. A method according to any preceding claim, wherein said placing step comprises placing said piece of refractory metal material (16;32) over an area of an investment cast compact to be repaired.

16. A method for repairing a tip portion (10) of a turbine blade comprising the steps of:

positioning a refractory metal backing material (16) over an area to be repaired (12); and

depositing a repair filler metal material (20) over said refractory material and welding said repair filler metal material.

17. A method according to claim 16, wherein said positioning step comprises positioning a piece of refractory metal material (16) selected from the group consisting of niobium, tantalum, molybdenum, tungsten, a metal having a melting point higher than the melting point of nickel, and alloys thereof over said area to be repaired (12).

18. A method according to claim 16 or 17, wherein said positioning step comprises positioning a piece of refractory metal material (1A) plated with a nickel containing material over said area to be repaired (12).

19. A method according to claim 16 or 17, wherein said positioning step comprises positioning a piece of refractory metal material (16) coated with a chromium containing material over said area to be repaired (12).

20. A method according to claim 16 or 17, wherein said positioning step comprises positioning a piece of refractory metal material (16) having an oxide ceramic coating layer, an intermediate layer of silicide, and a plated nickel outer layer over said area to be repaired (12).

21. A method according to any of claims 16 to 20, further comprising removing said refractory metal material (16) after said welding step has been completed using an acid chemical treatment.

22. A method according to any of claims 16 to 20, further comprising removing said refractory metal material (16) after said welding step has been completed using an oxidizing heat treatment.

23. A method for repairing a trailing edge (30) of a turbine blade comprising:

cutting a refractory metal material foil (32) to conform to a trailing edge shape of said blade;

positioning said cut refractory metal material foil (32) over a portion (34) of said trailing edge to be repaired; and

applying a repair filler metal material over said refractory metal material foil (32) and welding said repair filler metal material to effect said repair.

24. A method according to claim 23, wherein said cutting step comprises cutting a foil material (32) formed from a refractory metal selected from the group consisting of niobium, tantalum, molybdenum, tungsten, a metal having a melting point higher than the melting point of nickel, and alloys thereof.

25. A method according to claim 24 or 25, wherein said foil material (32) has a nickel plating thereon.

26. A method according to claim 24 or 25, wherein said foil material (32) has a chromium coating thereon.

27. A method according to any of claims 24 or 25,

wherein said foil material (32) has a nickel plated ceramic coating thereon.

28. A method according to any of claims 23 to 27, further comprising removing said refractory metal foil material (32) after said welding step has been completed using an acid chemical treatment.

29. A method according to any of claims 23 to 27, further comprising removing said refractory metal foil material (32) after said welding step has been completed using an oxidizing heat treatment.

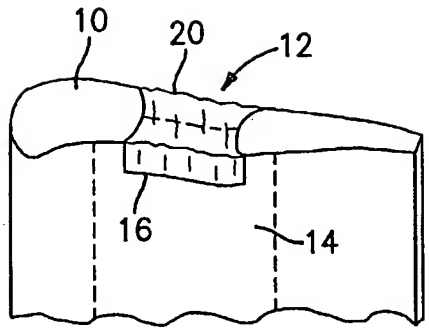

FIG. 1

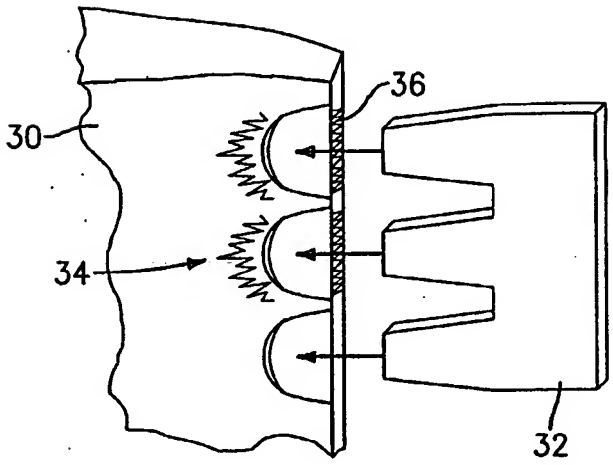

FIG. 2

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 25 3664

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
X A	EP 1 065 026 A (ALSTOM POWER SCHWEIZ AG) 3 January 2001 (2001-01-03) * paragraphs [0006],[0007],[0019]-[0022]; figures 3,7-9 *	1,2,9, 10,13,15 3-8,11, 12,14	B23K9/04 B23K10/02 B23K26/34 B23K37/06 B23P6/04
X Y	EP 0 924 020 A (UNITED TECHNOLOGIES CORP) 23 June 1999 (1999-06-23) * paragraphs [0006],[0053]-[0077]; figures * ---	1,2,9,10 16,17, 23,24	F01D5/00 F01D5/18
X Y	US 5 553 370 A (J. PEPE) 10 September 1996 (1996-09-10) * column 3, line 45 - column 4, line 42; figures * ---	1,2,16, 17,23-34 9,10	
X	DE 198 34 238 A (J. ROEDERS) 10 February 2000 (2000-02-10) * the whole document * ---	1	
Y A	US 5 701 669 A (R. MEIER) 30 December 1997 (1997-12-30) * column 5, line 22 - column 7, line 48; figures 1,2 * ---	9,10 3-8, 18-20, 25-27	TECHNICAL FIELDS SEARCHED (Int.Cl.7) B23K B23P F01D
Y	US 5 479 704 A (K.-H. RICHTER ET AL) 2 January 1996 (1996-01-02) * abstract; figure 1B * ---	16,17, 23,24	
A	US 3 957 104 A (A. TERPAY) 18 May 1976 (1976-05-18) * the whole document * --- -/--	2-8,13, 14,18, 19,21, 22,25, 26,28,29	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	12 September 2003	Jeggy, T

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 25 3664

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 6 332 272 B1 (JUNKIN JOHN E ET AL) 25 December 2001 (2001-12-25) * abstract; figures *	1,16,23	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	12 September 2003	Jeggy, T

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 03 25 3664

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

12-09-2003

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1065026 A	03-01-2001	EP 1065026 A1	03-01-2001
		US 6405435 B1	18-06-2002
EP 0924020 A	23-06-1999	US 6119383 A	19-09-2000
		US 6007628 A	28-12-1999
		US 6034344 A	07-03-2000
		US 6082291 A	04-07-2000
		EP 0924020 A2	23-06-1999
		JP 11245087 A	14-09-1999
		SG 80000 A1	17-04-2001
		JP 11218001 A	10-08-1999
		SG 66497 A1	20-07-1999
US 5553370 A	10-09-1996	NONE	
DE 19834238 A	10-02-2000	DE 19834238 A1	10-02-2000
US 5701669 A	30-12-1997	DE 19547903 C1	20-03-1997
		FR 2742688 A1	27-06-1997
		GB 2308321 A ,B	25-06-1997
US 5479704 A	02-01-1996	DE 4327189 A1	16-02-1995
		CA 2130068 A1	14-02-1995
		DE 59405692 D1	20-05-1998
		EP 0638387 A1	15-02-1995
US 3957104 A	18-05-1976	NONE	
US 6332272 B1	25-12-2001	AU 2761601 A	24-07-2001
		CA 2393282 A1	19-07-2001
		EP 1247003 A1	09-10-2002
		WO 0151772 A1	19-07-2001

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82